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JAPANESE INDUSTRIAL STANDARD

Testing Methods for Optical Properties of Plastics

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JAPANESE INDUSTRIAL STANDARD JIS

Testing Methods for Optical Properties of Plastics K 7105-1981
(Reaffirmed: 1992)

1. Scope

This Japanese Industrial Standard specifies the testing methods for optical properties of plastic materials(1).

Note (1) Plastic materials herein mean plastic materials in filmy and platy forms and of formed products.
In the case of the yellowness testing method, plastic materials shall also include those in the form of powder, pellets, filament and liquid.

2. Definitions

The definitions of the main terms used in this standard shall be as specified in JIS K 6900, JIS Z 8105, JIS Z 8113 and JIS Z 8120 and shall also be as specified below:

(1) light receiving angle The angle formed between the optical axis of the light receiving system and the normal line to the specimen surface.

(2) specular glossiness The ratio of reflected light flux to incident light flux in specular reflection.

(3) transfer standard white surface The transfer standard white surface shall be a surface prepared by forming a barium sulfate powder, in which the spectral reflectance factor has been graduated by calibration. The transfer standard white surface shall be used for calibration of working standard white surfaces.

(4) working standard white surface A durable white surface of known spectral reflectance factor, which is normally used as a standard for comparison in the measurement of spectral reflectance factor.

(5) glare-proofness The degree in which glare is prevented.

(6) yellowness The degree in which the hue removes from colorless or white toward yellow, which is expressed as a positive quantity. Consequently, when this is obtained by calculation as a negative value, it means that the hue transfers to the direction of blue.

(7) yellowing factor A factor used for evaluation of the degree of deterioration of plastic materials exposed to an environment such as light, heat and the like, which is expressed by the difference between the initial yellowness and that obtained after exposure.

(8) retrogressive reflection The phenomenon in which light is reflected toward the direction of illumination.

(9) image clarity The property of the surface of a coating which reproduces the image of an object facing the coating surface.

(10) distinctness of image The degree of distinctness of an image which is transmitted or reflected.

Applicable Standards: See page 6.

relative to the optical axis of the incident light. According to the purpose of observation, the angle of incidence shall be -50°, -40°, -30°, -20°, -10°, -4°, 0°, 10°, 20°, 30°, 40° or 50° (the lefthand and righthand directions perpendicular to the plane containing the angle of observation shall respectively shown as + and -), and the angle of observation shall be 0.2°, 0.3°, 0.5°, 1.5° or 2.0° as a standard, and any combinations of these two kinds of angles may be used on agreement between the parties concerned.

6.5.5 Measuring Method Calibration curves shall be prepared preliminarily by using two calibrating test pieces whose values of reflection intensity have preliminarily determined, and after adjusting the graduation of the measuring apparatus by using one of the calibrating test pieces, the test specimen shall be subjected to measurement and the intensity of reflection of the specimen shall be obtained from the calibration curve.

6.5.6 Method of Determination of Reflection Intensity Values of Calibrating Test Pieces The values of intensity of reflection of the calibrating test pieces shall be determined by measuring the illuminance on the receptor, produced by the reflection from the calibration test piece at the angle of incidence for each angle of observation, under the conditions of angle of incidence and angle of observation specified in 6.5.4 by placing a projector (which uses the standard light A as the light source, emits parallel light flux, and has a diameter of 50 mm) and a receptor (which agrees with the standard relative luminous efficacy and has a reception aperture of 12.7 mm × 25.4 mm in size) 30 m or more apart from the calibrating test piece; then the intensity of reflection shall be calculated from the following formula:

$$R = \frac{E_r \cdot d^2}{E_s \cdot A}$$

where R: intensity of reflection

E_r: illuminance on receptor produced by reflected light from specimen (lx)

E_s: normal illuminance produced by incident light at the position of specimen (lx)

d: measuring distance (m)

A: surface area of specimen (m^2)

Depending on the purpose of measurement, the illuminance applied on a unit surface area (10 cm^2) of the calibrating test piece may be adjusted to 10.76 lx and the intensity of reflection from the calibrating test piece measured. In such cases, the unit of intensity of reflection used shall be cd/10.76 lx.

6.5.7 Expression of Results The intensity of reflection shall be expressed by integer.

In addition, the angle of incidence and the angle of observation shall be appended as in the following Example:

Example: $R = 96$, angle of incidence -4°, angle of observation 0.2°

6.6 Distinctness of Image

6.6.1 Summary The distinctness of image shall be calculated from the results obtained by measuring the light transmitted through or reflected by the specimen through a moving optical comb by using a measuring apparatus for distinctness of image. However, the measurement shall be performed by the

transmission method for transparent specimens and by the reflection method for opaque or translucent specimens.

6.6.2 Apparatus The principle of the apparatus based on the transmission method is shown in Fig. 14, and that of the apparatus based on the reflection method is shown in Fig. 15. The apparatus shall consist, as shown in Figs. 14 and 15, of an optical system in which the light passed through a slit and made into parallel light beams is applied to the specimen, perpendicularly in the case of the transmission method and at an angle of 45° in the case of the reflection method, and the transmitted light or regular reflection light is detected through a moving optical comb, and of a measuring system which records the variation in the detected light quantity as wave form; in addition, the apparatus shall meet the following requirements:

(1) The light source used shall be of the S-C-8 type specified in JIS C 7711 with a filament thickness of 0.05 mm or less in diameter, and shall provide a constant light quantity during measurement.

(2) The width of the slit shall be 0.03 ± 0.005 mm.

(3) The optical comb used shall be such that the ratio between the widths of the dark part and the light part is 1 : 1, the width of those parts consists of the four stages of 0.125 mm, 0.5 mm, 1.0 mm and 2.0 mm, and the moving speed is about 10 mm/min.

(4) The wave height of the wave forms measured without the specimen attached in the case of the transmission method, and that measured under the condition in which a black glass standard surface(7) is fitted on the specimen base in the case of the reflection method, shall be equal when the light is passed through either one of the four kinds of optical comb widths.

Note (7) The black glass standard surface used shall be a smooth surface of black glass as specified in 5.2.3 (2).

(5) The output of the receptor shall be capable of being adjusted so that the correct value of distinctness of image can be obtained even for specimens whose transmittance or reflectance is low.

Fig. 14. Principle of Measuring Apparatus by Transmission Method

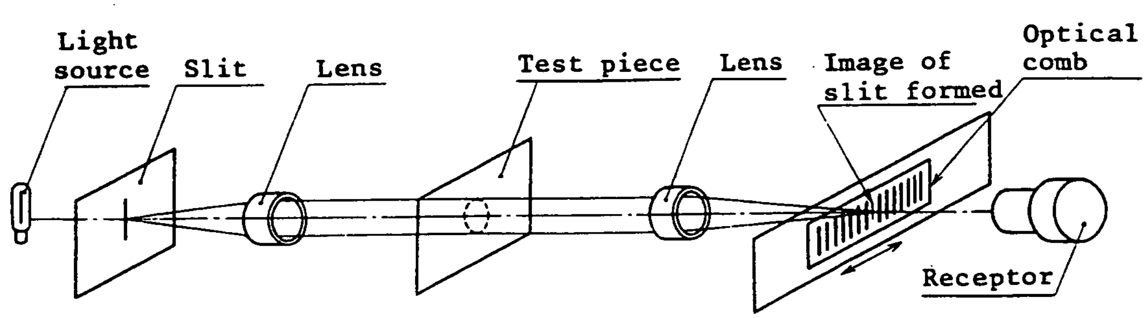
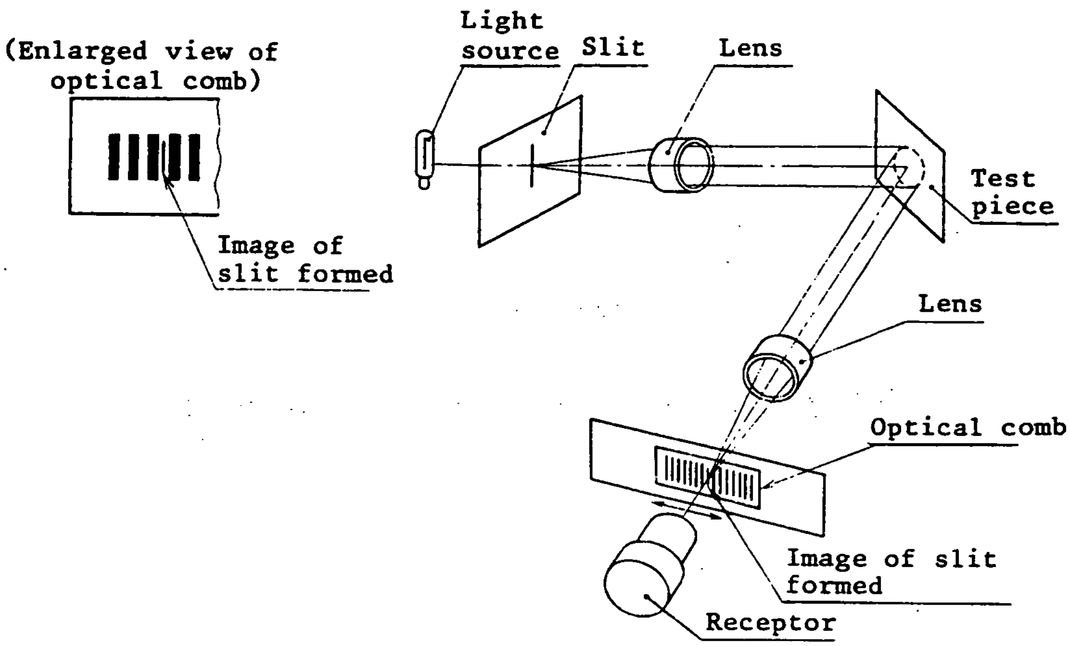


Fig. 15. Principle of Measuring Apparatus by Reflection Method



6.6.3 Test Piece The test pieces shall be as follows:

(1) The size of the test piece shall be 50 mm × 50 mm, with the thickness being the original thickness.

(2) The number of test pieces used shall be 3.

6.6.4 Measuring Method The measurement shall be carried out as follows:

(1) With the specimen base of the apparatus in the condition without the specimen attached in the case of the transmission method, and in the condition with a black glass standard surface attached in the case of the reflection method, move the optical comb and record the wave form of the received light (see Fig. 16). In this case, make adjustment so that the recorded wave height for the dark part of the optical comb becomes zero.

(2) After attaching the specimen to the specimen base, move the optical comb to make adjustment so that the maximum recorded wave form comes to a suitable position on the recording paper sheet in order to facilitate the measurement.

(3) Perform measurement by moving the optical comb within the range of a prescribed width and reading the maximum wave height (M) and minimum wave height (m) on the recording paper sheet (see Fig. 17).

(4) Perform measurement with respect to both the longitudinal and transverse directions of the test piece.

Fig. 16. Wave Forms of Received Light without Specimen and with Black Glass Standard Surface (In the Case of an Optical Comb Having 4-Staged Width)

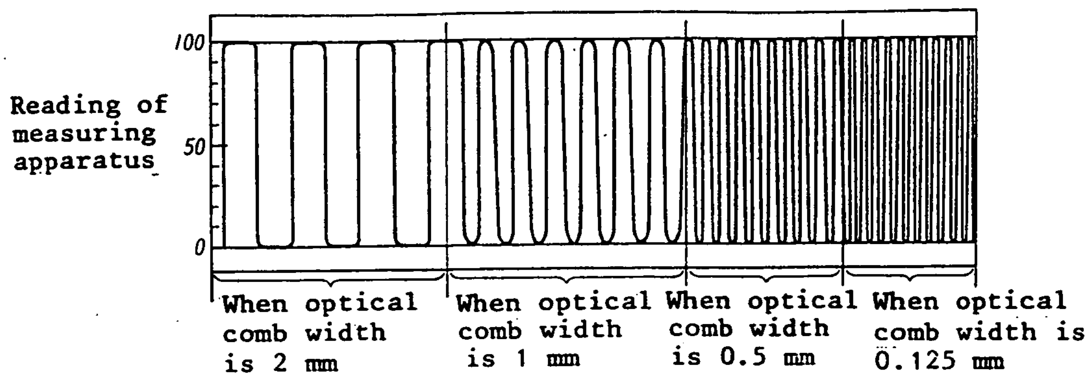
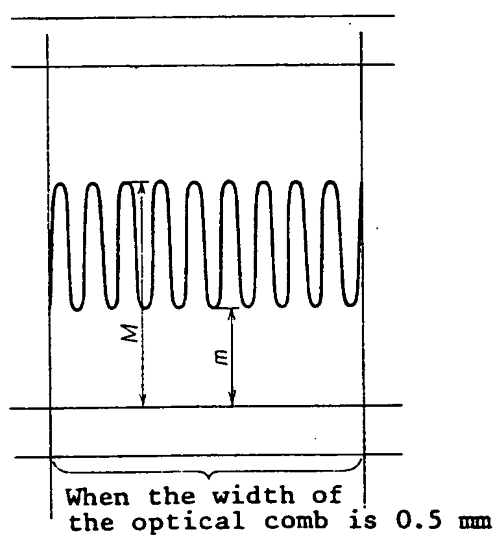


Fig. 17. An Example of Wave Form of Received Light by Specimen (In the Case of 0.5 mm Optical Comb Width)



When the width of the optical comb is 0.5 mm,

$$M=55$$

$$m=25$$

$$C=\frac{55-25}{55+25}\times 100=37.5\%$$

6.6.5 Method of Calculation The distinctness of image shall be calculated from the following formula:

$$C=\frac{M-m}{M+m}\times 100$$

where C: distinctness of image (%)

M: maximum wave height

m: minimum wave height

6.6.6 Expression of Results The distinctness of image shall be expressed to the 1st decimal place, with the optical comb width used appended in parentheses, as shown in the following Example:

Example: Longitudinal $C_{(0.5)}=37.5\%$

Transverse $C_{(0.5)}=37.0\%$

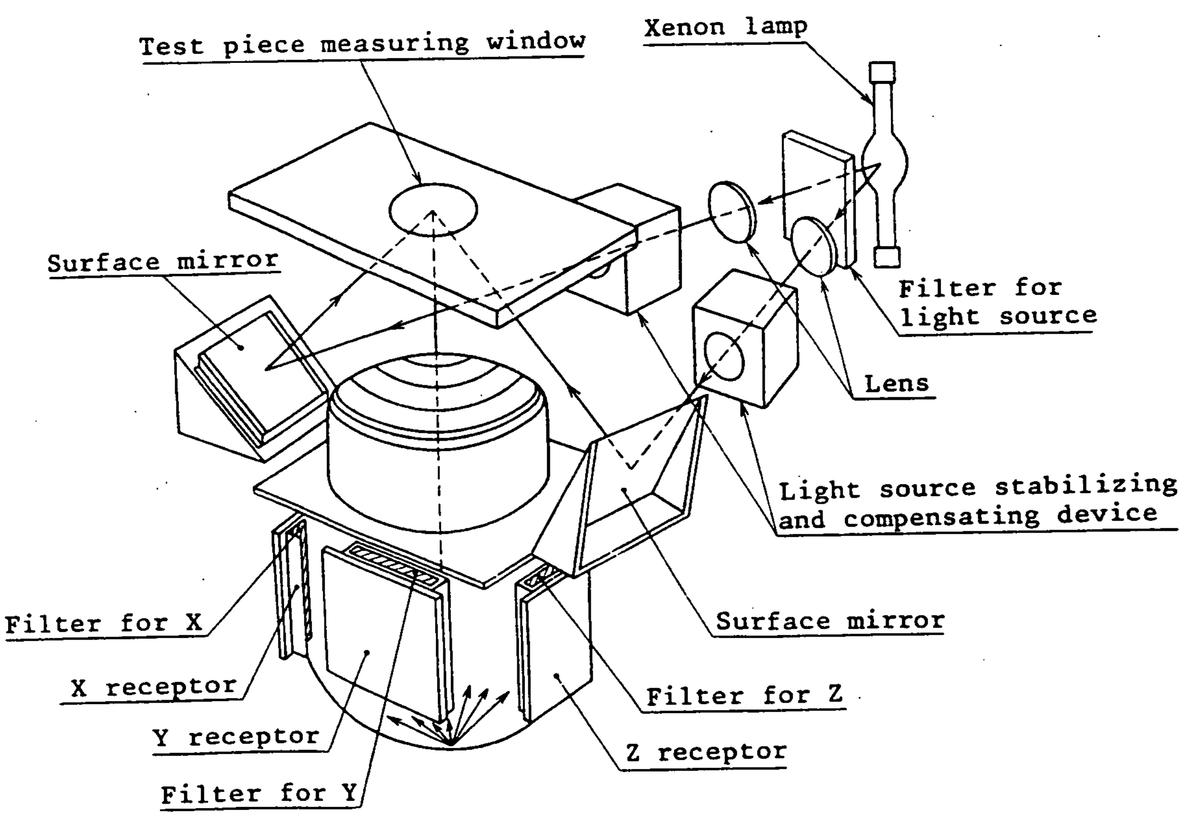
6.7 Fluorescent Colour

6.7.1 Summary The fluorescent colour shall be obtained by calculating the chromaticity coordinates x_f and y_f from the tristimulus values X_f, Y_f and Z_f measured by a xenon fluorescence colorimeter.

6.7.2 Apparatus The apparatus used shall be a xenon fluorescence colorimeter. The xenon fluorescence colorimeter shall use as the light source a xenon standard white light source as specified in JIS Z 8902 and be capable of measuring X_f, Y_f and Z_f directly from the indication of the meter and shall satisfy the Luther condition sufficiently.

The geometric conditions of illumination and light reception shall be such that illumination is applied from the direction of 45° relative to the specimen surface and the reflection in the normal direction is received. The principle of the xenon fluorescence colorimeter is shown in Fig. 18.

Fig. 18. Principle of Xenon Fluorescence Colorimeter



Remark: The filter used for the light source shall be as specified in Table 3 of JIS Z 8902.

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